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Review on Boosting Online Advertising ROI: Using Machine Learning

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---ABSTRACT--
Engagement of users with internet encourage and makes online advertisement as one of the prominent marketing strategy compare to traditional advertisement. Online advertisement marketing industry earn good amount of ROI floating marketing message on various online platform like social media, search engine, video marketing etc. With the diverse usage of online platform and variety of digital devices online industry struggling to reach right audience at right time with right content. Integration of machine learning techniques helps to reach target audience and maximize ROI in online advertisement Industry. Machine learning algorithm works on huge volume of data to predict probable customer and also helps to increase effectiveness of advertisement campaign. This review paper presents a comprehensive examination of the current state of research and practice in the domain of leveraging machine learning to enhance online advertising ROI.

Keywords - **Machine Learning Techniques, Online advertisement metrics, Online advertisement, Real Time Bidding**

1. INTRODUCTION

Online advertisement, one of the marketing strategy delivering marketing messages to targeted customers in right time using internet on smart devices. Engagement of users with smart devices and widespread adoption of social media platform and search engines encourages and open door for the online advertisement industry growth. With the exponential growth in audience, diversity of online platform as well as variety of smart devices, online advertisement industry are presented with both unprecedented opportunities and challenges. Online advertisement industry whose key players spending millions of dollars expect high Return on Investment and struggling for effective advertisement campaign to reach targeted audience. In this context, advance growth in Machine learning provide promising solution to target audience, pattern analyze and many more issues of online advertisement industry.

Traditional online advertisement campaign depend on human expertise, intuition and historical data analysis. However, huge volume and complexity of online advertisement data and to handle rapidly changing audience behavior, require more advance and data-driven approach. Machine learning algorithm that automate decision-making processes and significantly enhance advertising ROI. Combination of Machine learning algorithm with deep learning can better target audiences and allocate budget wisely in dynamic online advertising marketing.

This review paper aims to study the current state of research in the machine learning with combination of deep learning applied in online advertisement industry to boost ROI. It aims to highlight how ML techniques interact with various advertisement parameters to increase prediction and pattern analysis of online advertisement industry. By analyzing research papers, this review summarize key findings, challenges and opportunities which offer roadmap for not only advertiser but also researchers.

The paper is organized as follows with important research goals. First goal is to present an overview of various types of online advertisement and second goal is to present review on how ML approach used to boost ROI for advertisement campaign. A background is presented in Section-2 for types of Online Advertisement which execute on various platform like mobile, desktop, connected TV etc. Section-2 also cover details regarding online advertisement working system with brief introduction of various key players and Real time bidding procedures. Online advertisement campaign ROI is affected by various key metrics which is also covered in background part. Section-3 present literature review of various Machine learning algorithms and deep learning used for various types of advertisement.Section-4 marks conclusion with challenges and future directions.

2. BACKGROUND

2.1 Types of an Online Advertisement

Online advertisement consists of a wide range of formats and channel intended to connect and engage targeted

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audiences on internet. Online advertisement can be displayed on various platform like Search engine, Social media platform, website, blogs, video sharing platform, gaming platform, mobile apps etc [26]. In Table 1 we have summarized various types of online advertisement.

Table 1: Various Types of Online Advertisement

Types	Meaning
Display Advertising	Display ads which appear on websites or apps used for brand awareness,product promotion and lead generation.e.g banner ads,image and rich media ads.
Search Engine Advertising	Display on search engine result page intented to capturing users actively seraching for product,service or information e.g Google Ads
Social Media Advertising	Social media offer various form like image,video,live stream,stories etc to promote advertisement Social media platform e.g Facebook,Instagram,Twitter e.g
Video Advertising	Short video clips played on various platform like Facebook,youtube etc.
Native Advertising	Native ad blend with the website page's original content and are not annoying users.
Email Marketing	Effective way for nurturing leads.It will send promotional message to subscribers or target audience.
Affiliate Marketing	Affiliates promote product or service and charge commission to advertiser for driving traffic
Influencer Marketing	Approach by most followed social media influencers who recommend product/service.
Remarketing/Retargeting	It will try to convince consumer for purchaes product/service who have previously visited website or brand. This strategy helps to increase ROI of advertisement capagine.
Programmatic	It will help to sell publisher
Advertising	adspace to the buyer(advertiser) in Real time bidding process of online advertment.
Mobile Advertising	Applicable to mobile devices.
Content Marketing	Strategy which share releavant article/video to retain an audience.
Interactive Advertising	It engage consumers by allowing them to interact with advertisement in the form of games, quiz, poll etc.
Geotargeted Advertising	It makes use of a user's location to deliver relevant ads.Its effective for local businesses and events.
Voice Search Advertising	It handle voice queries.e.g Amazon Alexa,Google Assistant

2.2 Real-time Bidding for Online Advertising: component and process

Digital advertising uses Real-time bidding (RTB), which involve many intermediaries and technologies as show in fig. 1 to provide buying and selling facilities of ad impression efficiently to advertiser and publisher respectively. RTB , where online auction occurs to sell individual ad impression often in a matter of milliseconds. Publisher earn highest price per advertisement impression and advertiser target specific audience with the help of RTB [25].

RTB process compromises of following steps;

Step 1:User interact with web page/app which raise request for advertisement to SSP(Supply side platform).

Step 2:Request sent to the Ad exchange.

Step 3:Ad exchange distribute Ad space/slot infomation to all DSPs(Demand side platform).

Step 4:DSP algorithm generate bids for matching advertiser campaign.

Step 5:Generated bid are sent back to the Ad exchange.

Step 6:Ad exchange perform auction with the various recevied bids.Advertisement with the highest bidding price and matching critria is winner of auction.

Step 7:Winner advertisement is sent to publisher platform.

Step 8:Some useful metrics information like user engagement with advertisement, advertisment impression etc data are provided to publisher and advertiser to analysis effectiveness of advertisement campaign.

Step 9:Winner advertiser pay bid amount to pubilsher/ad exchange/ssp.

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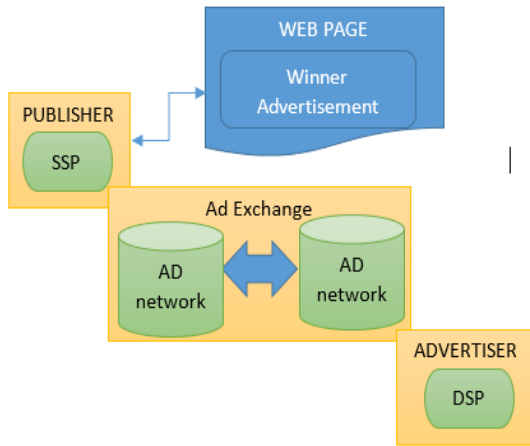
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Fig. 1. Real Time Bidding Process in Online Advertisement

2.3 Online advertisement metrics

In the context of Real-Time Bidding (RTB), various metrics are used to measure the performance and effectiveness of ad campaigns. These metrics help advertisers and publishers assess the impact of their ads and optimize their strategies. Below discussion focus on some of the online advertisement metrics.

Click-Through Rate (CTR), helps to find out the percentage of users engaging with advertisement. Number of advertisement click is divided by number of advertisement impression, is a formula to retrieve CTR. Conversion rate, metrics which measures the percentage of users who completed a desired action. Advertiser use publisher platform to target audience and advertiser will pay for each click on their ad, known as Cost Per Click. Advertiser use strategies to maximize click and conversion rate.

Effectiveness of advertisement campaign measured using Cost per Acquisition (CPA) which calculated by dividing the cost of total campaign with total number of user conversion.

To measure influence of advertisement View-Through Rate (VTR) which measures the percentage of users who saw an ad and later converted without clicking on the ad. VTR is related to display and video ads. Reachability of advertisement campaign is measured using Impression share which indicates the percentage of available ad impressions that a campaign or ad group received. It assess whether ad campaign is reaching its target audience and whether there are missed opportunities.

Metrics named Ad Position, indicates where an ad is displayed on a webpage or within a mobile app. Higher ad position represent more visibility to users and advertiser track it to optimize ad placement. User engagement with advertisement assess on parameters like time spent on an ad, interaction rate, video completion rate etc. Ad Engagement metric assess how users engage with the ad creative.

Advertisement campaign profitability or loss measured using Return on Investment (ROI). ROI measures, comparing the revenue generated from the campaign to the cost of running it. Positive value indicate profitability and negative value represent loss. Frequency metrics indicates how many times same ad impression is presented to same users. High frequency value have negative impact on users.

Relevance of ads and keywords help to measure Quality Score used by advertising platforms .Higher quality scores can lead to better ad placement and lower CPC.

Goal of advertiser is to convert interacting user into customer. Click-Through Conversion Rate (CTCR) uses to measures the percentage of users who clicked on an ad and subsequently converted. It helps evaluate the direct impact of clicks on conversions.

3. RELATED WORK

Online advertising industry is indeed a multi-billion-dollar Industry. Publisher and Advertiser spend huge amount of money and efforts for successful advertisement campaign. Online advertising offers better measurement and tracking capabilities compared to traditional advertising, enabling advertisers to assess their return on investment (ROI) more accurately.

Machine learning's capability to process and analyze vast amounts of data that influence advertisers and publishers in the dynamic and data-driven world of online advertising. It enables them to make data-informed decisions, improve ROI, and enhance the user experience.

In [11] Deep learning network used with multi head attention model merge with feature named user interest. Used model learn advertisement feature interaction that are used for CTR prediction. Online advertisement impression generated using various form. In[12] author highlights different types of advertisement like display ,search , social and various forms of advertisement types are explored .User demographics information are collected and how its effect on customer choice for product are analyzed.

Online advertisement dataset have huge amount of data and full large-scale information causes overfitting problem and to resolve it in [13] author proposed hybrid approach which integrates Factorization-Machine Based Neural Network (DeepFM) and Gated Recurrent Unit Neural Network (GRU).

In [14] author studies, RTB that interact with advertiser and publisher for advertisement bid auction and show how ad impression buy and sale process works. Advertiser need optimal strategy for spending budget to reach wider range of audience. Author explore efficient budget management, bidding strategy for display advertisement for low quality impression.

In [15] highlights different online advertisement metrics used to evaluate effectiveness/success of a campaign, Conversion rate, product subscription, web site traffic, RTB etc. with machine learning techniques which used to make

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improvements in metrics for effective advertisement campaign.

Machine learning techniques like Logistic regression, factorization machine which consider low order feature interaction while deep neural network consider high order feature interaction. In [16] joint learning models are proposed such as wide & Deep and DeepFM which exploit both high and low order features interactions.To improve accuracy of CTR prediction,[17] author have used sparse feature learning method from deep learning point of view. Due to high volume of data and nonlinear association between features they have explored data dimensionality reduction method.

In[18] author have used 10 days mobile advertisement data with four classification techniques, namely K Nearest Neighbor (KNN), Logistic Regression, Random Forest, and Extreme Gradient Boosting (XGBoost) where XGBoost produced ROC-AUC of 0.76.

To enhance CTR prediction accuracy on Contextual advertisement, in [19] Simple linear regression and multivariate linear regression algorithm used. Optimization done for feature selection process.

To understand non-linear relationship between features, in [20] Hybrid approach with CNN (Convolutional Neural Networks) and FM (factorization machine) is used. Author used CNN to extract high-impact features and FM used to predict and classifies them. In [21] display advertisement type is with feature named ad placement is used to build model using Random forest, decision tree and SGD based Logistic regression.

In [22] author build a model to predict CTRs of new key-phrases using ads that already have enough historical data and calculated CTR. Regression algorithm is applied

4. FUTURE DIRECTION AND CHALLENGES

Artificial intelligence including machine learning and deep learning play crucial role in online advertisement industry.
Online advertisement industry working with huge amount of data. Researchers can integrate online advertisement industry with Machine learning algorithm for Audience targeting, predictive analytics, Ad personalization, Ad placement optimization, Real-Time Bidding (RTB),Ad creative testing ,click fraud detection, Dynamic Pricing, churn prediction, Ad Quality Control, Recommendation engines, Click through rate prediction etc.

Online advertisement suffering from Ad Fraud, global challenge which cause by bot or malicious attackers to drain advertisement budget are detected using ML, AI and deep learning techniques [8].

5. CONCLUSION

In conclusion, this review paper has study the potentiality of machine learning in boosting ROI of online advertisement marketing industry. Through an analysis of various research studies and practical applications, this review has highlighted overview of the various combination of Machine learning and Deep learning algorithm approach used to leverage ROI in online advertisement industry. Continues growth in AI technology promise the synergy between AI and advertising that will shape the way businesses connect with their audiences in the digital age.

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